



Prevalence of common sensitizing aeroallergens in Egyptian asthmatic patients

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ABSTRACT

Background: Aeroallergens and food allergens play a key role in the pathogenesis of asthma; they are the target for future immunotherapy worldwide. Food allergens have been studied often in Egypt, but data are defective concerning the prevalent Egyptian aeroallergens that can be affected by the climatic conditions in Egypt. So, our study aimed to explore the dominant sensitizing aeroallergens in Egyptian patients with bronchial asthma.

Methods: Cross-sectional study performed on 122 Egyptian asthmatic patients. Sera from all patients were examined by enzyme allegro sorbent test (EAST) method for specific IgE to a panel of 18 inhaled allergens.

Results: Positive specific IgE to aeroallergens was detected in 43.44% of our patients. German cockroach (18.9%) was the most frequent sensitizing aeroallergen amongst our asthmatic patients, followed by the fungal allergens (15.57%) and house dust mites (HDMs) (13.93%).

Conclusion: German cockroach, fungi, and house dust mite are the chief sensitizing aeroallergens in Egyptian asthmatic patients.

Keywords: Asthma, Aeroallergens, Egypt

INTRODUCTION

Atopic asthma is classified as an IgE-mediated disease, due to sensitization to allergens including inhaled allergens. Aeroallergens trigger eosinophilic inflammation and airway hyper-responsiveness via various immunological cells, orchestrated by T helper 2 (Th2) cell and its

released cytokines. According to World Health Organization (WHO) prevalence of asthma is approximately 300 million patients around the world; moreover, it is anticipated to become 400 million by 2025.¹ In Egypt, asthma is estimated to be 8.2% and 6.7% among children and adults respectively, being more predominant in males than females (1.2:1).^{2,3}

Allergens accountable for developing asthma in genetically predisposed individuals, are available in their surrounding environment, either indoor or outdoor. Consequently, aeroallergens could be classified into two groups; outdoor allergens such as pollen grains, fungal spores, dust particles, and non-specific irritants, and indoor allergens such as house dust mites (HDMs), animal and fungal allergens.⁴

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Climate and other geographical characteristics prominently impact the prevalence of diverse aeroallergens. Temperature and dew point were observed to be the main predictors of mold spore counts. Furthermore, high temperature leads to augmented pollen generation. This strongly reinforces the need for more research work, inspecting the frequent sensitizers in various countries. This will enhance diagnosis and management of asthmatic cases.⁵

According to World Allergy Organization (WAO) 2018, there is no available information concerning the prevalence of aeroallergens in Egypt except for mold and yeast allergens.⁶ This study aims to elucidate the prevalence of common sensitizing aeroallergens among Egyptian patients with asthma.

SUBJECTS AND METHODS

A cross-sectional study was conducted on 122 asthma patients, children and adults diagnosed as asthma under the Global Asthma Guidelines Initiative.⁷ They were collected from the clinics of Pediatric Pulmonology and the Allergy and Immunology Clinic of Internal Medicine, Ain Shams University, from July 2018 to July 2019.

The study omitted immunocompromised patients, patients with COPD, and any other chest comorbidity. Clinical history (including residence and environmental exposures) and medical review were applied to the selected patients. Laboratory investigations included the following: a) assay of serum total IgE b) assay of specific IgE sensitization for a panel of perennial aeroallergens. Full blood samples were collected and permitted to coagulate for both assays, and the serum was isolated by centrifugation and stored at -20°C .

Total IgE testing was performed using a commercially available solid-phase sandwich enzyme immunoassay kit (IgE Quantitative test kit, Chemux Bioscience, Inc. U.S.A.). The absorption value for each specimen was used to determine the appropriate IgE concentration in IU/ml from the standard curve. Reference range was: 0 - <1 yr: 0-15 IU/ml, 1- <5 yrs: 0-60 IU/ml, 5 - <9yrs: 0-90 IU/ml, 9 - <15yrs: 0-200 IU/ml, 15 yrs or older: 0-150 IU/ml.

A commercially available kit (ImmunoLINE IgE Perennial, IMMUNOLAB GmbH, Kassel, Germany) was used to detect common allergen-related IgE antibodies in serum. The package is based on the enzyme allegro sorbent test (EAST) theory in which common allergens are applied to a solid phase carrier (strip). On each strip, 18 separate perennial allergens and cross-reactive carbohydrate determinant (CCD) were coated in parallel lines. The panel of allergens included: Cat epithelia, dog epithelia, horse epithelia, guinea pig epithelia, pigeon feathers, hen feathers, and *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, German cockroach, *Penicillium chrysogenum*, *Cladosporium herbarum*, *Aspergillus fumigatus*, *Candida albicans*, *Alternaria tenuis*, *Trichophyton mentagrophytes*, straw dust, cotton, and sheep's wool. The sera of patients were added to the pre-wetted test strips and incubated in the tray at room temperature. The serum IgE antibodies linked to the allergens that are immobilized. The strips were rinsed and the alkaline phosphatase conjugated to anti-human - IgE was added and incubated. After washing steps, the substrate was applied and incubated. Then the strips were rinsed with the wash solution and the color formation was finished. To get quantitative results, the intensity of the color of the precipitated lines on strips were evaluated using a scanner and Immunolab's Line-Blot Diagnostic Tool software. The degree of sensitization was expressed in 3 levels: values < 0.35 U/ml as negative, 0.35-2 U/ml as low titer, 2.1-17.49 U/ml as moderate titer and 17.5 U/ml or more as high titer.

Statistical methods

For the social sciences version 20 program (SPSS; SPSS Inc., Chicago, Illinois, USA), the data collected were tabulated and analyzed. Categorical data were reported as numbers and percentages, while quantitative data were reported as mean \pm SD. The same analysis of Fisher and the π^2 test were used to compare various groups. In this study, the agreed level of significance was defined at 0.05, and therefore the value of P less than 0.001 was considered highly significant, the value of P less than 0.05 was considered significant, and the value of P greater than 0.05 was considered negligible.

RESULTS

In the current research, 122 subjects suffering from bronchial asthma were enrolled. Males represented 60.7% of them, while females were 39.3%. Mean age was 16.61 ± 12.31 years, ranging from 3 to 55 years. Concomitant allergic rhinitis was diagnosed in 42 patients, (34.42%) of the

Aeroallergen	N (%)
German cockroach	23 (18.9)
Fungi	19 (15.57)
House dust mites	17 (13.93)

Table 1. The most frequent sensitizing aeroallergens among the studied patients

studied group. Mean serum total IgE level was $188.95 \text{ IU/ml} \pm 167.75$, and ranged from 4 to 800 IU/ml.

Positive specific IgE to the studied aeroallergens was detected in 53 (43.45%) of our patients, by utilizing EAST method. Mono-sensitized patients accounted for 13.11% of all cases, while poly-sensitized was 30.33%.

As demonstrated in Table 1, German cockroach was the most frequently sensitizing aeroallergen (18.9%), followed by fungi (15.6%) and HDMs (13.9%). *Candida albicans* and *Cladosporium* were the most common sensitizing fungal species (12.3%, 8.2% respectively). *Aspergillus* and *Penicillium* sIgE were both detected in 6.6% of cases. As regards HDMs, positive sIgE to *Dermatophagoides pteronyssinus* was observed

Aeroallergens	Total Prevalence No. (%)	Low titer No. (%)	Moderate titer No. (%)	High titer No. (%)
Cat epitheliae	5 (4.1)	3 (2.5)	0 (0)	2 (1.64)
Dog epitheliae	8 (6.6)	4 (3.28)	4 (3.28)	0 (0)
Horse epitheliae	4 (3.3)	2 (1.64)	2 (1.64)	0 (0)
Guinea pig epithelia	0 (0)	0 (0)	0 (0)	0 (0)
Pigeon feather	9 (7.4)	7 (5.74)	2 (1.64)	0 (0)
Hen feather	10 (8.2)	4 (3.28)	4 (3.28)	2 (1.64)
<i>Dermatophagoides pteronyssinus</i>	17 (13.9)	9 (7.38)	4 (3.28)	4 (3.28)
<i>Dermatophagoides farinae</i>	10 (8.2)	4 (3.28)	4 (3.28)	2 (1.64)
German cockroach	23 (18.9)	13 (10.66)	8 (6.56)	2 (1.64)
<i>Penicillium chrysogenum</i>	8 (6.6)	0 (0)	8 (6.56)	0 (0)
<i>Cladosporium herbarum</i>	10 (8.2)	2 (1.64)	8 (6.56)	0 (0)
<i>Aspergillus fumigatus</i>	8 (6.6)	0 (0)	8 (6.56)	0 (0)
<i>Candida albicans</i>	15 (12.3)	7 (5.74)	8 (6.56)	0 (0)
<i>Alternaria tenuis</i>	8 (6.6)	2 (1.64)	4 (3.28)	2 (1.64)
<i>Trichophyton mentagrophytes</i>	8 (6.6)	4 (3.28)	4 (3.28)	0 (0)
Straw dust	9 (7.4)	7 (5.74)	2 (1.64)	0 (0)
Cotton	1 (0.8)	1 (0.82)	0 (0)	0 (0)
Sheep wool	0 (0)	0 (0)	0 (0)	0 (0)

Table 2. Results of EAST test to tested aeroallergens among asthmatic patients

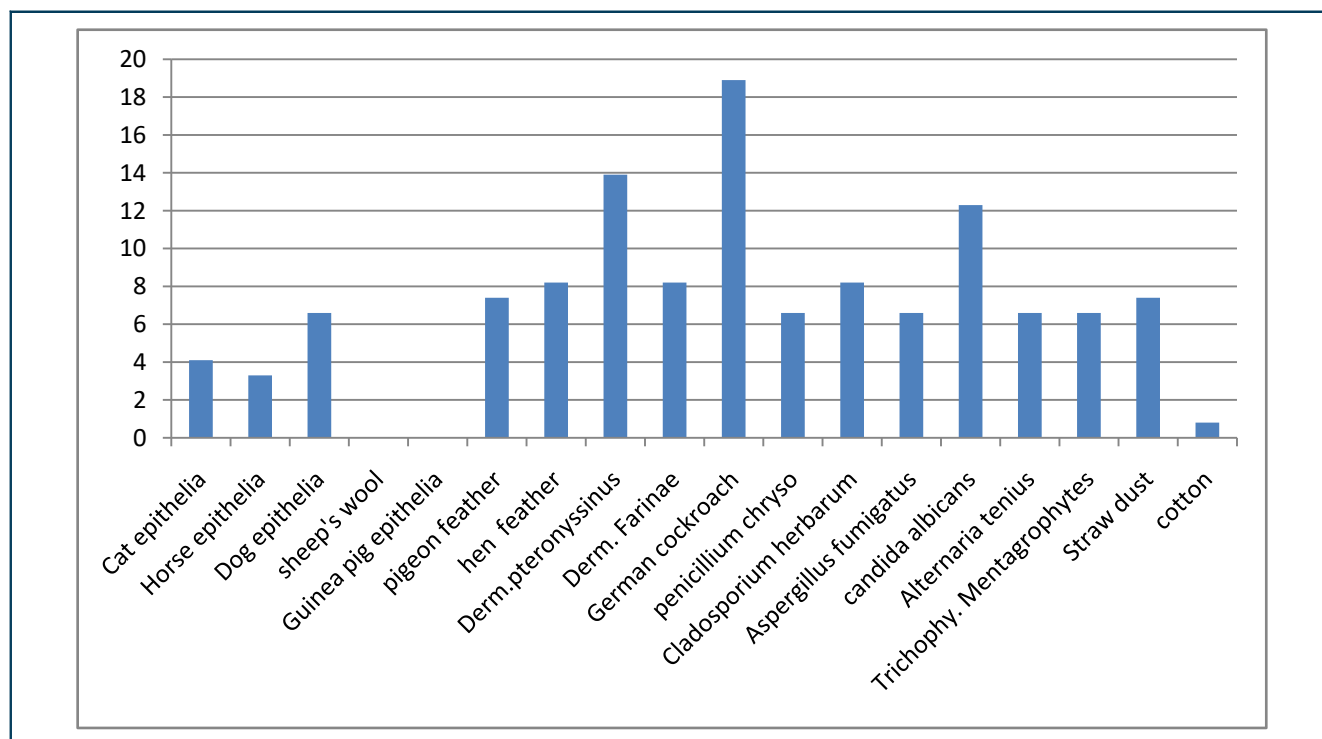


Fig. 1 Prevalence of positive specific IgE sensitization to aeroallergens among studied patients (%)

among 13.9% of patients compared to 8.2% to *Dermatophagoides farinae*. With respect to animals, dog epitheliae followed by cat and horse epitheliae were positive in 6.6%, 4.1% and 3.3% of patients respectively. Moreover, sensitization to feathers of hen and pigeon were almost similar (8.2% and 7.4% respectively). No patients were sensitized to guinea pig epithelia or sheep wool (Table 2, Fig. 1).

The study group included 78 children (under 18 years of age) and 44 adults. Table 3 indicates the sensitization rates with respect to age. There was a general trend towards a decline in sensitization rate in the adult population. Results showed significant decrease in sensitization to *Candida albicans*, *Alternaria tenuis*, and straw dust in the adult category with P-value (0.05, 0.03 & 0.02, respectively). On the other hand, in the adult group, sensitization to German cockroach increased significantly relative to the group of children with (P value = 0.001) (Table 3) (Fig. 2).

In Table 4, we compared frequency of sensitization among asthmatic patients with and without allergic rhinitis. Only *Dermatophagoides*

farinae showed significantly higher results among those with allergic rhinitis (10%), compared to 4.8% among the other group (P value = 0.032). Other than that, no significant difference was detected.

DISCUSSION

More than 43 percent of Egyptian asthmatic patients were positively sensitized to at least one of the studied 18 aeroallergens by utilizing EAST. This percentage goes with various studies conducted worldwide; eg, the sensitization to aeroallergens was 33.38% in India,⁸ 42.8% in sub-Saharan Africa, 34% in Tunisia,⁹ and 30.7% in Uganda.¹⁰

Nevertheless, this outcome is different from other studies done in Egypt directed to one allergen, as the study of Khatab et al. (2017) which stated that 74% of Egyptian patients with allergic asthma and/or allergic rhinitis had positive results to at least one fungal allergen extract using skin prick test (SPT).¹¹ That study was a cross-sectional study, done at the Allergy Outpatient Clinic of Ain Shams University Hospital in the period between February 2015 to June 2016, and it included 200 patients. Their ages ranged from 6 to 70 years old

	Children (N = 78)		Adults (N = 44)		χ ^{2a}	P-value
	N	%	N	%		
Cat epitheliae	3	3.8%	2	4.5%	0.04 FE	1.00
Dog epitheliae	4	5.1%	4	9.1%	0.72	0.40
Horse epitheliae	4	5.1%	0	0.0%	2.33 FE	0.30
Pigeon feather	7	9.0%	2	4.5%	0.81	0.37
Hen feather	4	5.1%	6	13.6%	2.71	0.10
Dermatophagoides pteronyssinus	13	16.7%	4	9.1%	1.35	0.25
Dermatophagoides farinae	6	7.7%	4	9.1%	0.07	0.79
German cockroach	8	10.3%	15	34.1%	10.45	0.001
Penicillium chrysogenum	4	5.1%	4	9.1%	0.72	0.40
Cladosporium herbarum	6	7.7%	4	9.1%	0.07	0.79
Aspergillus fumigatus	4	5.1%	4	9.1%	0.72	0.40
Candida albicans	13	16.7%	2	4.5%	3.83	0.05
Alternaria tenuis	8	10.3%	0	0.0%	4.83	0.03
Trichophyton Mentagrophytes	6	7.7%	2	4.5%	0.46	0.50
Straw dust	9	11.5%	0	0.0%	5.48	0.02
Cotton	0	0.0%	1	2.3%	1.79 FE	0.36

Table 3. Comparison between asthmatic children and adults as regard frequency of sIgE sensitization to the studied aeroallergens a. Chi square test.

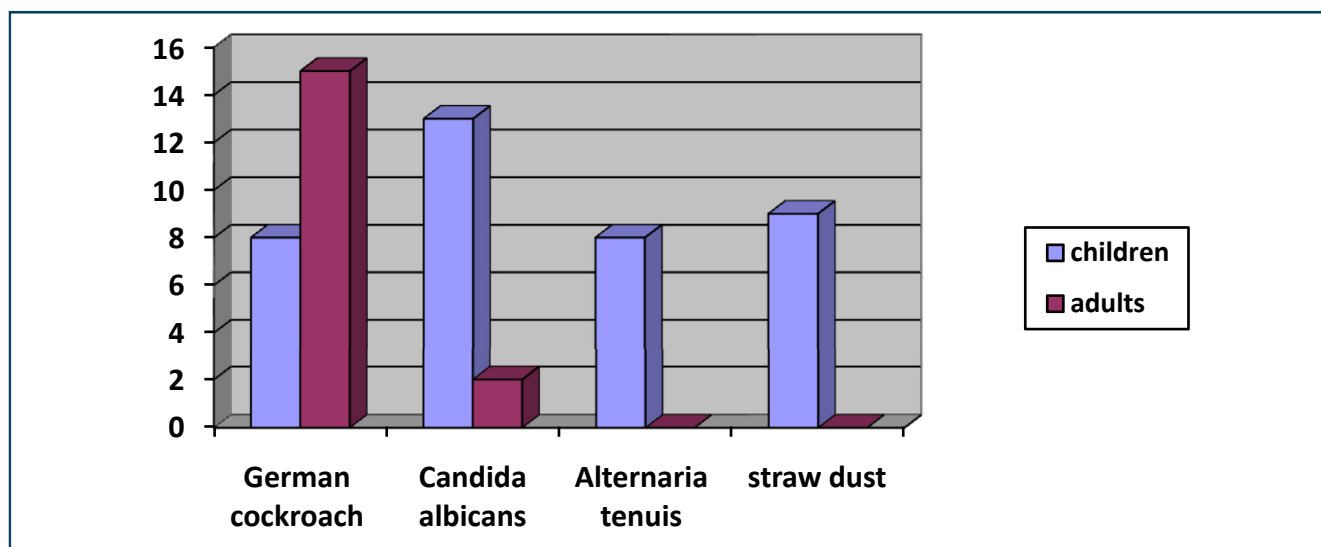


Fig. 2 Aeroallergens with statistically significant difference in the frequency of specific IgE sensitization between asthmatic children and asthmatic adults

	Asthma with allergic rhinitis (N = 42)		Asthma without allergic rhinitis (N = 80)		X ² _a	P value
	N	%	N	%		
Cat epitheliae	5	6.3%	0	0.0%	2.74 FE	0.10
Dog epitheliae	6	7.5%	2	4.8%	0.34	0.56
Horse epitheliae	4	5.0%	0	0.0%	2.17 FE	0.30
Pigeon feather	5	6.3%	4	9.5%	0.43	0.51
Hen feather	4	5.0%	6	14.3%	3.16	0.08
<i>Dermatophagoides pteronyssinus</i>	14	17.5%	3	7.1%	2.46	0.12
<i>Dermatophagoides farinae</i>	8	10.0%	2	4.8%	1.00	0.032
German cockroach	19	23.8%	4	9.5%	3.64	0.06
<i>Penicillium chrysogenum</i>	4	5.0%	4	9.5%	0.92	0.34
<i>Cladosporium herbarum</i>	6	7.5%	4	9.5%	0.15	0.70
<i>Aspergillus fumigatus</i>	4	5.0%	4	9.5%	0.92	0.34
<i>Candida albicans</i>	13	16.3%	2	4.8%	3.37	0.07
<i>Alternaria tenuis</i>	6	7.5%	2	4.8%	0.34	0.56
<i>Trichophytonmentagrophytes</i>	6	7.5%	2	4.8%	0.34	0.56
Straw dust	6	7.5%	3	7.1%	0.01	0.94
Cotton	1	1.3%	0	0.0%	0.53 FE	1.00

Table 4. Comparison between asthmatic patients with and without allergic rhinitis concerning prevalence of sIgE sensitization to aeroallergens among The bold represent the allergen (*Dermatophagoides Farinae*) that has statistically significant difference among asthmatic patients with and without allergic rhinitis. a. Chi square test.

with the mean age of 32.2 ± 14.4 years. Only 14% of the patients were below 14 years, and 20% were more than 45 years. It was directed to study sensitization to fungal allergens only. The skin prick test was done on ten fungal extracts. The difference between the studies could be due to the use of skin prick test that has variable false positive and false negative results and including elderly patients in the study. This is in contrast to our study in which the mean age of our patients was 16.61 ± 12.31 years, with about 65% of the patients below 18 years.

German cockroach was the most common sensitizing aeroallergen in 18.9% of the Egyptian

patients with bronchial asthma included in our study. Positive results to fungal spores were yielded in 15.57% of our patients, followed by HDMs in 13.93% of them. This is in harmony with many studies especially that done in Palestine, which reported also that cockroach was the most prevalent sensitizing aeroallergen (12%).¹² Another one accomplished in Kuwait concluded that cockroaches and HDMs were the most common indoor allergens.¹³ Conversely, in Oman, the most prevalent aeroallergens were HDMs (37.8%), followed by feathers (33.3%), sheep wool (26.6%), and cockroach (22.7%).¹⁴ In Iran, HDMs were positive among 90.5% of asthmatics, then molds (80.7%) and animal dander (77.5%).⁴

While in Saudi Arabia, the leading indoor allergens were HMDs, then cat, cockroach, and fungi.¹⁵ This could be clarified by the high temperature and humidity in those territories, which favor the prevalence of certain allergens. In Asian countries, HDMs were the most widely spread sensitizing inhaled allergens, followed by cockroach, molds, and animal dander.¹⁶ Discrepancy of findings from different countries could possibly be attributed to diverse weather and environmental conditions.

In many studies, cockroach was declared to be a chief cause of developing atopic asthma, especially in urban regions. This was linked to the increased exposure to air pollution in these areas.¹⁷ In our study, cockroach sensitization was evident in 18.8% of asthmatic patients, of which 1.64% had high titer. In 1995, El-Gamal et al, detected positive specific IgE antibodies to cockroach in the sera of 84% of Egyptian children with asthma, of which 16.28% showed high titres.¹⁸ But, El-Gamal et al, studied smaller sample size and in pediatrics only, which may explain their surprisingly very high outcome. Interestingly, we found higher prevalence among adults than that amongst children (P-value = 0.001), this finding was in line with a large retrospective Chinese study.¹⁹

Cockroach sensitization was found to be 25% in Poland.²⁰ Nevertheless, it was 58% in Taiwan.²¹

Fungi are also prominent aeroallergens, which are abundant both indoors and outdoors; they are related directly to increased humidity.²² In our study, prevalence of fungal sensitization was 15.57%, where *Candida albicans* was the most common (12.3%), followed by *Cladosporium*, *Alternaria*, *Penicillium* and *Aspergillus*. Diverse studies were interested in sensitization to fungi in asthmatic patients in Egypt; one of them was in 2006. They isolated molds from some flats where children suffering from respiratory atopy settled. *Cladosporium cladosporioides* followed by *Alternaria alternate*, *Penicillium chrysogenum* and *Aspergillus* were the most common types prevalent in both indoor and outdoor samples.²³ The second one showed that *Alternaria* and *Penicillium* were the most prevalent molds among patients with respiratory allergy, followed by *Aspergillus* and other fungi.¹¹ Awad et al, conducted a study in 2002 to explore airborne

fungi in urban and rural regions in Egypt. They reported that *Alternaria*, *Aspergillus*, *Cladosporium*, *Penicillium*, and yeasts were the most available indoors and outdoors species in Egypt.²⁴ Regarding other geographically related countries, the most prevalent sensitizing fungi in Kuwait was *Candida albicans* (23.1%).²⁵ *Cladosporium* was the most common species of fungi in Sudan (42%),²⁶ Qatar,²⁷ Jordan,²⁸ and Turkey.²⁹ *Alternaria* spores were reported as the most common fungal allergens in Kingdom of Saudi Arabia (KSA).¹²

HDMs are regarded as significant indoor allergens. The climate in Egypt favors the propagation of HDMs. Secretions, feces, and the products of body degradation can probably increase the risk of allergic diseases.³⁰ In our sample, 13.93% of patients were sensitized to HDMs, in which 13.9% of patients were sensitized to *Dermatophagoides pteronyssinus* and 8.2% to *Dermatophagoides Farinae*. Such findings strongly support a study conducted by Hossny et al, who studied the sensitization of asthmatic Egyptian children to 5 forms of HDMs. They concluded that 24% of the Egyptian asthmatic children were sensitized to HDMs. Also they found that *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae* were the most popular causing sensitization in 12% and 11% of patients, respectively.³¹ Another study done by Abd Ella et al, concluded that the prevalence of sensitization to HDMs in atopic patients was 36.36%.³² The yields of our study were lower than the above mentioned studies due to the use of different techniques and enrollment of different age groups. Due to varying environmental conditions, eg, in the UAE and KSA, sensitization to HDMs was 46% and 27%, respectively, in different countries. It was also much higher in Brazil (73.5%),³³ Mexico (56%), Taiwan (85%), and South India (89.7%). On the other hand, in Vietnam (9–23%) and North India (7.8%), their prevalence was lower. It is evident that HDMs are more prevalent in warm, humid subtropical areas.³⁴

One of the main reasons for allergic asthma is animals. Dogs cause sensitization by their dander, epitheliums, and salivary protein. Cats also produce many allergens from their salivary, perianal, and sebaceous glands. The resemblance between different dog and cat allergens (eg, albumins and lipocalins) and other mammals may explain the

cross-reactivity regardless exposure to dogs, cats, or both.³⁵ Cat and dog allergy prevalence was 4.1% and 6.6%, respectively, in our study. In other nations, this figure is much smaller than that. While in Saskatchewan, Canada cat dander sensitization was found in 58.2% of patients.³⁶ Also in USA, 24% were sensitized to cat and 16% to dog.³⁷ This difference may be due to more ownership of dogs and cats in some countries than others, especially if the exposure is in the first year of life.³⁸ Hugg et al. studied dogs' and cats' role on children from Russia and Finland to develop asthma. It was demonstrated that early exposure to cats in childhood raised the risk of developing asthma, while exposure to dogs seemed to be protective.³⁹ Svanes et al, also noted that having dogs in infancy increases the risk of non-allergic asthma among non-atopic subjects, but reduces the risk of allergic sensitization.⁴⁰ This is against the Illi et al, study (2012), which found that early exposure to dogs increased risk of atopy.⁴¹

Straw sensitization among our studied group was 7.4%, and it was noteworthy that they were all children. Illi et al, concluded in 2012 that contact with straw was a protective element to asthma.⁴¹

As the prevalence of breeding birds at home is high in Egypt, 8.2% and 7.4% of our patients have been sensitized to hen feather and pigeon, respectively. In line with this, a study carried out in Iran showed that feathers' sensitization was positive in 13% of asthma patients.⁴²

CONCLUSION

Aeroallergens cause sensitization to 44.26% of asthmatic patients in Egypt. German cockroach is the most sensitizing aeroallergen. Enhancement of modes of combating cockroach is highly recommended.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the development of the paper. All authors approved the final version.

ETHICAL APPROVAL

The study was approved by local ethics committee, Pediatric department, Faculty of Medicine, Ain Shams University.

Consent of publication

Written and verbal consent was taken from the participating patients and the caregiver of children.

Conflict of interest

None.

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